Analysis of tri-axial force and vibration sensors for detection of failure criterion in deep twist drilling process

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Deep twist drilling technique with length per diameter ratio of more than 10 is widely used, especially in tool and die industries. This technique can improve the quality and production of drilling products by increasing feed rate and can shorten the machining time. The limitation in this process is premature tool breakage due to tool wear, chip clogging, and tool failures. In this study, deep drilling process was analyzed via cutting force and vibrations by using three-axis force dynamometer and accelerometer sensors to detect failure criteria. Deep twist drills were analyzed through cutting parameters, such as cutting speeds, feeds, and depth of cut. The effects on the tool condition during cutting operations were measured by three-axis data of vibrations and force sensors and then analyzed in time and frequency domain. Results indicated that both sensors are capable of monitoring tool conditions. However, data produced by vibration sensors are more appropriate to detect initial conditions before tool failure. Thus, monitoring tool conditions in three axes can lead to precise data and earlier detection in the y axis instead of in the z axis. Cutting condition analysis found that cutting speed and feeds of more than 50 m/min and 0.25 mm/rev, respectively, result in tool failures under safety threshold in x, y, and z. Tool monitoring conditions in three axes are useful to show the deep drilling process failure criterion, such as good, small corner wear, large corner wear, blunt, and fracture. Tri-axial sensors are useful in developing an online condition monitoring tool for deep drilling process, especially in tool and die industries.